Application of Modigliani-Miller theorem to banking sector

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Оглавление

Introduction

The 2007-2008 started in US but soon affected other countries causing huge losses of economic output and financial wealth. It was associated with losses and failures of financial companies that made regulators rethink capital adequacy requirements for banks to reduce the fragility of global financial system.

New banking regulations adopted worldwide require banks to increase capitalization, introduce minimum liquidity requirements and aim to switch from bail-out to bail-in. In order to comply with Basel III banks need to hold 8.5% in reliable assets (Tier 1 ratio) instead of 4% under Basel II. This significant increase in capital requirements caused a heated discussion between regulators and bankers concerning effects of its adoption for the economy. Regulators believe that current leverage level is excessive and can be reduced to create more stable financial system without negative effect on the economy[1]. At the end of 2014 tangible equity ratio was only 4.97% in US and 3.86% in other countries (for global systemically important banks)[2], while average tier 1 capital ratio was above 12%. These numbers suggest that even with the switch to stricter capital requirements there is still a room for improvement. At the same time bankers point out that increase in funding costs after new regulations are adopted is imminent as equity financing is expensive compared to debt. This increase, if happens, would lead to lending rates growth, decline in lending activities and impair economic growth.

To determine the actual effect of capital regulations on lending activities and justify either of expressed opinions the impact of capital ratio increase on cost of equity and total cost of capital should be quantified. Financial theory says that source of financing have no impact on company's value and funding costs in absence of frictions. This result is known as Modigliani-Miller irrelevance theorem Weather banks can be considered as normal "firms" or due to their specific nature Modigliani-Miller theorem cannot be applied is a question we need to answer.

In this paper we empirically examine link between bank capital adequacy ratio and cost of capital for 21 largest US, Eurozone and UK banks. We provide quantitative comparison of leverage impact on cost of capital among sample countries and quantify impact of liquidity risk and efficiency ratio on costs. We also discuss history of Basel committee and details of Basel III capital regulations and focus on theoretical aspects of MM theorem applicability to financial companies.

[1] Financial Times. (Nov. 9, 2010) Healthy banking system is a goal, not profitable banks. [Online] Available from: http://www.ft.com/intl/cms/s/0/63fa6b9e-eb8e-11df-bbb5-00144feab49a.html [Accessed: 5th May 2015]
[2] FDIC Global Capital Index as of December 31, 2014. [Online] Available from: https://www.fdic.gov/about/learn/board/hoenig/capitalizationratios4q14.pdf [Accessed: 1st May 2015]

Chapter 1. Basel accords

History of Basel accords

Breakdown of Bretton Woods system was followed by a disturbances in currency and banking markets. German Bankhaus Herstatt's bank failed in 1974 triggering losses for banks around the world on their trade with Herstatt. Following these events G-10 decided to establish a new supervisory authority later named Basel Committee on Banking Supervision. The committee aims to establish financial stability, regulate international cooperation on banking supervision and improve supervision quality. Nowadays committee includes 27 member countries and European Union.

Until 1980s banking regulation and supervision was relatively simple. At the beginning of 1980s Latin America countries, extensively financed by banks borrowings, were no longer able to service their debt of $327 billion. As a result of Mexican insolvency in 1982 and followed defaults of other Latin America countries, international banks stopped oversees lending. These events raised concerns about deterioration of banks capital ratios and increased fragility of new financial system. Recognizing the need to harmonize capital requirements and enhance resilience of financial system to crisis Basel Committee issued first Basel Capital Accord in 1988. Basel I became the first international capital regulation initiative. It introduced weighted approach to risk measurement by categorizing assets into 5 categories, with risk weighting of 0%, 20%, 50%, 100% and assets that were fully deducted from capital. It also introduced notion of Tier 1 capital, which included loss absorbing equities and hybrid instruments. Banks were required to have a minimum capital to risk-weighted assets ratio of 8% of which 4% should be Tier 1 Capital. It was a simple framework to present banks' balance sheet, but as Andrew Bailey mentioned in his speech at Bloomberg (Bailey, 2014) it did not provide enough insights into risk management and created incentive to increase average riskiness of banks assets.

Basel I evolved into Basel II, which was published in 2004, but fully implemented only in 2007. It introduced three new pillars of capital management:

1. Minimum capital requirements that should, apart from credit risk, take into account operational and market risks;
2. Key principles of supervisory review and risk management guidance enebling supervisors to set additional capital requirements on firm-by-firm basis;
3. Disclosure requirements as an instrument to develop market discipline and increase transparency of the information.

Basel II did not introduce new definitions of capital or new levels of capital requirements. By implementing mentioned above pillars it extended banks' ability to use proprietary models of market risk capital requirements first introduced in 1996 and known as Market Risk Amendment. It is important to note that neither Basel I nor Basel II did not place limits on leverage in addition to risk-based requirements.

Unfortunately Basel II was not sufficient to protect financial system from the crisis. With collapse of Lehman Brother, bailout of Bear Stearns and turmoil in global financial markets excessive banks leverage again compelled attention of regulators once again.

In response to the financial crisis the Basel Committee designed another reformed referred as Basel III. It changes definition of Tier 1 capital making Common Equity Tier 1 (common equity and retained earnings) the predominant form of Tier 1 capital. By 2019 banks should have minimum ratio of Common Equity Tier 1 capital of 4.5% (excluding additional buffers). Basel III aims not only to generally heighten capital requirements, but also to introduce liquidity standards to address maturity mismatch and stabilize deleveraging, make regulations countercyclical by promoting additional capital buffers and further reduce risk of largest international banks by imposing additional loss absorbency requirement.

Countercyclical capital conservation buffer value lies in range from 0 to 2.5% depending on macroeconomic situation. Up to 2.5% of additional loss absorbency is required to be hold by systemically important banks[3].

The table 1 compares minimum capital requirements of Basel II and Basel III, which will fully come into force in 2019.

Table 1. Comparison of Basel II and Basel III (with capital conservation buffer) requirements

	Basel II	Basel III
Common Equity Tier 1 Ratio	2%	7%
Tier 1 Capital Ratio	4%	8.5%
Total Capital Ratio	8%	10.5%

Discussion of benefits and costs of Basel III

Bank's capital regulations are an object of heated debates between regulators and bankers during years following introduction of Basel III. While regulators believe it to be an appropriate way to reduce social costs of high leverage and increase financial system stability, banker argue

[3] See Appendix 1 for list of banks and additional capital requirements.

that expensive equity financing will lead to lending rates increase and slow GDP growth. Some analysts also emphasize that new capital requirements will lead to reduction of ROE for the average bank by 4 percentage points in Europe (Härle et al., 2010). However ROE is calculated dividing net income by total equity, so it cannot take into account the risk of company's equity. Company can increase ROE by increasing leverage, but the risk will also increase. These changes in ROE do not reflect banks performance clearly as investors anticipate higher returns for higher risk. Thus pure ROE argument is not valid and corrected for risk ROE should be analyzed. This section summarizes results of studies on costs and benefits of new regulations for the economy.

Crises, if occur, cause significant damage to the economy. Mark Adelson (2013) estimate total losses of the recent financial crisis to be between $5 trillion and $15 trillion. He sees excessive leverage and risk-taking behavior of financial firms to be main causes of the crisis. Enhanced capital regulations should decrease probability of financial crises occurrence in the future and reduce its severity. Reinhart and Rogoff (2009) estimate that financial crisis lead, on average, to 10% reduction of GDP where 2.5% is permanent. Analysis of financial crises history (Hoggarth, Reis, Suporta, 2001) shows that average crisis in high-income countries last 4.1 years and costs 20.7% of GDP. This suggests great benefit of new regulations if they will reach their goal.

Researches show that increased capital requirements has ability to prevent crises. Probability of 2007 financial crisis in UK could have been reduced by 5 percentage points with 1 percentage point increase in capital requirements and would have dropped tenfold with 8 pp capital increase (Barrell et al. 2009). Kato, Kobayashi and Saita (2010) estimate optimal level of capital and conduct cost-benefit analysis of raising capital and liquidity requirements. If liquidity level is relatively high, 0.1 percent point increase in capital ratio results in 0.655 percent point reduction in the probability of crisis. Mooij et al. (2013) follow previous authors' methodology and explore the link between systemic banking crisis probability and leverage, controlling for liquidity and current account balance. According to their results the relationship between leverage ratio and crisis probability is nonlinear. Marginal impact of leverage on probability increase dramatically when leverage exceeds 92%. Higher equity can be considered as a substitute to bailout fund[4].

[4] Insights by Stanford Business (September 1, 2010) Anat Admati: Why Bank Equity Is Not Expensive [Online] Available from: https://www.gsb.stanford.edu/insights/anat-admati-why-bank-equity-not-expensive [Accessed 9th May 2015]

Some economists even believe current modifications in Basel requirements to be insufficient (Miles et al., 2012, Admati and Hellwig, 2013). They support the necessity of higher capital requirements but argue the required level of capital with Basel III to be insufficient to reach desired effect. Their argument is based on the shortcomings of current system of risk-weighted assets calculation, which tend to underestimate actual risk of the bank. Their research proves optimal level of capital of 20% of risk-weighted assets or even 20% of total assets.

Miles et al. (2012) study historical patterns of leverage and lending spreads in US and do not find any obvious dependence. While leverage was increasing during twentieth century, lending rate spreads did not have a decreasing trend. Nevertheless more precise econometric studies ((Cosimano and Hakura, 2011; Roger and Vlcek, 2011; Elliot, 2009; Elliot, 2010b; Angelini et al., 2011, EEAG, 2011, BCBS, 2010)) justify existence of positive relationship between capital ratios and interest rate margins. Kashyap et al. (2010) estimate long-run lending rates to increase by 25- 45 basis points for a 10 percentage-point increase in the capital requirement. Cosimano and Hakura (2011) expect smaller growth of lending rates under Basel III (by 16 basis point), to be accompanied by 1.3% fall in loan growth**.** Slovik and Cournède (2011) expect annual GDP growth to drop by 0.05-0.15 percentage points caused by larger interest spreads.

Although funding costs and lending rates spreads are expected to grow after Basel III implementation their separate study reflec mostly private costs for banks and not total costs for the economy. It is noted by Stein (2010) and Admati et al. (2013) that to analyze consequences of new capital requirements adoption the total social benefits should be measured. While banks benefits from high leverage to crease liquidity they also tend to overproduce it increasing negative externalities. When costs and benefits for the whole economy are compared, conclusions changes significantly.

Barrell et al. (2009) find positive impact of higher capital requirements on lending rates but the present value of higher capital ratios policy remains positive. Net benefits of new requirements reach its peak at additional 4 pp of capital. In Bank of England Financial Stability Report benefits and costs of higher capital requirements are compared for UK financial system. Authors find marginal benefit from additional capital which becomes insignificant only at capital level above 13% of risk-weighted assets.

Marchesi et al. (2012) use Bank of England methodology to analyze macroeconomic impact of deleveraging on 7 EU member countries. Their findings support bankers' predictions about funding costs and lending spreads as they are expected to increase by 2.67 bps and 5.57

bps for 1% change in minimum capital requirements correspondingly. Despite the increase in funding costs net benefits for the economy remain positive if capital requirements do not exceed 14.5% of RWA. This result is in line with BIS (2010a) which reports net benefits to exceed 1% of annually output. Additional capital requirements can also reduce amplitude of business cycle, but results can be impaired if financial intermediation activities will shift to non-regulated sector.

Several researches (Cosimano, Hakura, 2011, Kashyap et al., 2010) indicate the risk of shadow banking growth caused by new regulations. Acharya, Schnabl, and Suarez (2010) found connection between shadow banking development and Basel II and, as Basel III capital requirements are higher than its predecessor, the process might continue. The FSB (2011) defines "shadow banking system" as "credit intermediation involving entities and activities outside the regular banking system". Shadow banking system provides companies with alternative source of funding, but it is also a source of additional systemic risk as they are not subject to regulatory initiatives. Highly leverage shadow banking institutions are usually connected with traditional banks and used by them to avoid capital regulations. This interconnectedness with regulated financial companies, as well as liquidity and maturity risks are the main sources of concern associated with the growth of shadow banking. By the end of 2013 marginal contribution of shadow banking to systemic risk was above 10% in US and Euro area and it tends to increase during periods of distress leading to further destabilization of the economy (IMF, 2014). Therefore in order Basel III to be efficient it may require to adopt additional regulations for shadow banking entities.

Chapter 2. Literature review

Modigliani-Miller theorem

Modigliani Miller (MM) theorem was developed in 1958 and originally consisted of two propositions under assumption of perfect financial markets. There are four fundamental assumptions defining MM framework:

- Absence or neutrality of taxes;
- Absence of capital market frictions, such as transaction costs, trade restrictions and bankruptcy costs;
- Ability of firms and investors to lend and borrow at the same rate;
- Firm financial policy reveals no information.

Modigliani and Miller states that for any "class" of firms, the share price of a particular firm equals to expected income earned by the firm discounted by expected rate of return for this "class". Then they introduce a firm using debt and equity financing and establish connection between market value of the firm, which equals to market value of all its securities, and capital structure. This connection is known as Modigliani-Miller Proposition I

Proposition I: "market value of any firm (V_j) is independent of its capital structure and is given by capitalizing its expected return ($\bar{X}_j$) at the rate ρ_k appropriate to its class" (Modigliani, Miller, 1958). It can be expressed as,

$$V_j \equiv (S_j + D_j) = {\bar{X}_j}/{\rho_k}, \; D_j - \text{debt}, \; S_j - \text{equity}.$$

$${\bar{X}_j}/{V_j} = \rho_k.$$

Proposition I equals to the statement that cost of capital is independent from capital structure, which means $V_L = V_U$, where V_L is a market value of levered firm and V_U is the market value of unlevered company.

The proof of this proposition is based on the non-arbitrage condition stating that market values of two identical assets should be the same. They compare strategy of buying percent P of equity of levered firm and buying percent P of shares of unlevered company borrowing percent P of levered company's debt. As both strategies create the same income there is no difference in price of levered and unlevered company's shares.

Original second proposition of the theorem connected return of the firm's share, expected rate of return for the "class" of firms and leverage of the company.

Proposition II: "the expected yield of a share (i_j) of stock is equal to the appropriate capitalization rate ρ_k for a pure equity stream in the class, plus a premium related to financial

risk equal to the debt-to-equity ratio times the spread between ρ_k and r" (Modigliani, Miller, 1958).

$$i_j = \rho_k + (\rho_k - r)\frac{D_j}{S_j}, \text{ r – interest rate on debt}$$

It means that cost of equity will grow proportionally to leverage increase. This equation particularly reflects that investors require higher compensation for higher risk associated with leverage.

In their later work they correct initial results for tax level. As interest rate payments on taxes are usually deductible from taxable income they may create additional value for the firm. Therefore in the universe with taxes, other things equals, firm's value will increase the following way:

$$V_L = V_U + \tau D,$$

Where τ – tax rate and τD represents the value of the tax shield.

Correcting for taxes Modigliani and Miller obtain the following formula for equity yield:

$$i_i = \rho_k^\tau + (1-\tau)(\rho_k^\tau - r)\frac{D_i}{S_i},$$

Where ρ_k^τ – capitalization rate for after tax income, τ – tax rate.

Presence of taxes reduces reaction of equity cost to changes in leverage but general tendency remains unchanged: equity cost continue increase with increase in leverage. This result of Modigliani-Miller theorem is fundamental for our further empirical study as we would attempt to quantify the effect of decreasing bank leverage on cost of equity and total costs of capital.

Limitations of MM theorem

Modigliani-Miller theorem is the most widely used theoretical framework to assess changes in the cost of equity due to leverage. However its initial assumptions does not hold in the real world, so theoretical papers focus on evaluating the consequences of market frictions for MM conclusions. For our literature review on the debates of MM relevance for banking the assumptions listed above will also be the starting point.

First of all it is important to note that Modigliani-Miller worked on productive firm example and some researchers and bankers believe bank's unique nature of activity to be the cause of irrelevance of MM theorem for banks. Economists suppose that high leverage has different meaning for banks and tend to separate them in analysis from non-financial firms[5]. Therefore question we need to answer is: "To what extend this theorem can be applied to financial companies in modern "imperfect" world?" If the theorem holds true, new regulations

[5] Fama E.F., French K.R. (1992) The Cross-Section of Expected Stock Returns. *The Journal of Finance*. 47 (2). p. 427-465.

will push down return on equity reducing or completely eliminating impact of increased share of equity financing on total funding costs. MM cannot specify an optimal capital level for financial or any sector of the economy, but it is a useful instrument to understand nature of relationship between leverage and cost of capital.

There is still no agreement in academic researches on relevance of MM theorem to banking. Miller (1995) gives ambiguous answer on the question whether Modigliani-Miller theorem can be applied to banks. Kashyap et al. (2010) find that pure form of MM does not hold for banks, but conclude that small Modigliani-Miller effect is still significant and changes in cost of capital caused by a decrease of leverage are much smaller than expected. Most likely that pure MM irrevelance theorem does not hold not only for banks, but for any firm in the real economy (Pfleiderer, 2015).

The first assumption about absence or neutrality of taxes does not hold in practice. Debt provides taxation benefit as interest payments, contrary to dividends, are deductible from taxable income creating a "tax shield". Therefore high leverage is beneficial for both financial and non-financial companies. Cheng and Green (2008) conduct study of 129 European companies and show significant but small impact of corporate tax rate on leverage. They conclude that 10% increase in corporate tax rate would raise leverage in most countries by less than 1%. Results vary considerably among countries with a maximum reaction of 3.4% in UK and a minimum of 0.15% in Ireland. Weichenrieder and Klautke (2008) find that the similar increase in tax rate increases debt-to-asset ratio by more than 1.4 pp. Gordon and Lee (2000) show that small and large firms' capital decisions are most sensitive to tax rate changes. They estimate that 10 percentage points increase of the corporate tax rate causes debt financing to grow by 3.6% of assets. Stein (2010) confirms existence of fiscal benefits of debt, as previous authors did, but his results imply it has little impact on cost of capital.

Real financial markets are imperfect. They do not provide similar and full information for all participants and tend to over- or underestimate securities. This imperfection can make raising more equity inefficient and harmful for companies. Cosimano and Hakura (2011) find that changes in loan growth under the Basel III depend significantly on net cost of raising equity (return on equity relative to the marginal cost of deposits), which vary from 0 in Canada to 26 basis points in Japan.

On charts 1 and 2 we can see equity issuance statistics for Euro area.

Figure 1. Total net issues of shares in Euro area (% of GDP)

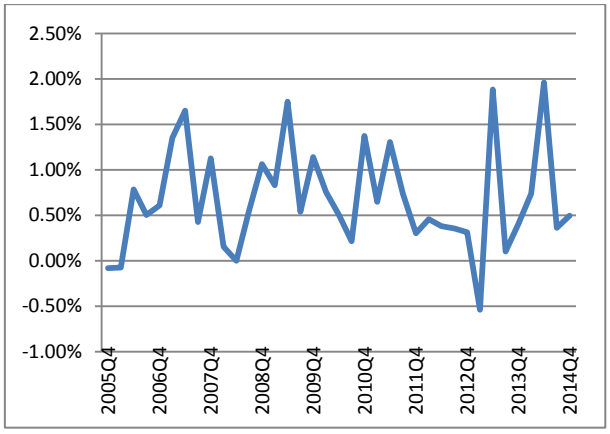
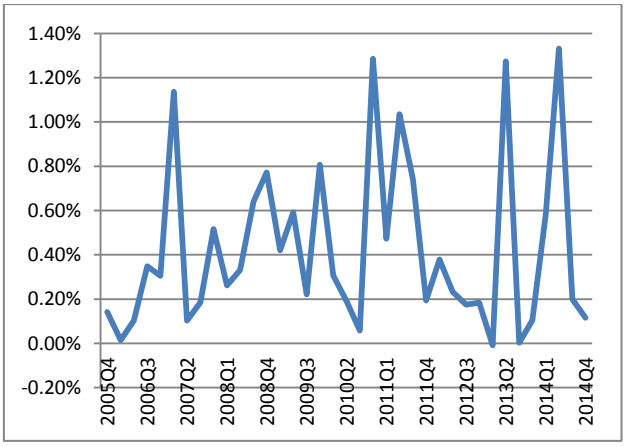


Figure 2. Net issues of shares of financial companies in Euro area (% of GDP)



Source: ECB

On the chart above we can notice low levels of equity issues in Euro area compared to GDP. Banks managers are reluctant to issue new equity as they consider it to be undervalued. New equity issuance would be considered by market as a negative signal. Admati et al. (2013) suggest government not only to set capital standards, but also to set schedule of equity issuance so investors won't consider new equity bearing negative information about banks performance. Market participants also may underestimate changes due to capital structure modifications and misprice securities (Pfleiderer, 2015).

High leverage increase probability of bankruptcy which is associated with specific bankruptcy costs. Bankruptcy costs involve costs associated with legal resolution process, loss of potential revenues and reputation losses. There is empirical evidence that bankruptcy costs are significant for both financial and nonfinancial companies. According to estimations these costs are in the range of 10-30 per cent (James, 1991, Andrade & Kaplan, 1998, Korteweg, 2010). Glover (2014) finds the mean default cost to be 45% of firm value, which empirical studies of defaulted firms produce cost of only 25%. As higher cost of default decrease net benefits of banks activity they will tend to choose less leverage to mitigate this effect.

Debt funding can produce agency benefits. There are several views on agency costs. It may represent the benefit of debt, as banks management fears the prospect of deposits withdrawal and high leverage may actually improve management quality.

"Debt is valuable in a bank's capital structure because it provides an important disciplining force for management." (French et al. 2010)

As too much equity capital increase agency problem Calomiris & Herring (2011) propose supplementary contingent capital requirement in the form of convertible debt. It can be converted if the trigger event occurs and immediately improve bank capitalization and prevent

agency problem from occurrence during relatively stable periods. Authors prove their solution to be a cheaper way to prevent banks failure and resolve too-big-to-fail problem.

The last two characteristics are specific for banks business model and product characteristics and may be the major causes why MM theorem is inapplicable for them.

Banks prefer debt to equity because, by doing so they profit from implicit government guarantees. There are guarantees for the liability side of bank's balance sheet in form of deposit insurance or to the asset side in the form of too-big-to-fail policy. Aboura and Lepinette (2015) a theoretical model of banks behavior in presence of debt guarantees by modeling guarantees as a free put option on banks debt provided by government to banks' bondholders. They introduce the notion of "guaranteed firm" as an opposition to "classical firm in standard Modigliani-Miller Theorem and conclude that "guaranteed firm" benefits from leverage. While guarantees are free, as government guarantees to banking sector MM does not hold. To maintain MM applicability to the banking sector guarantees should be sold. However nonbank financial firms that do not profit from deposit insurance are also characterized by high leverage (Herring, 2011). While the median ratio of leverage of nonfinancial companies is 3.0, it is above 12 for both bank and nonbank financial companies. Therefore it can be suggested that low capital ratio of banks is associated with fundamental characteristics of banking industry product.

Banks provide to clients 2 types of service: lending to those, who want to borrow, and socially valuable liquid financial claims for whose, who want to ensure sufficient liquidity during shocks. Mitchell Berlin (2011) says: "since liquid liabilities are a primary output of the banking firm, we should expect banks to be highly levered". DeAngelo and Stulz (2013) study leverage importance for banks in absence of imperfections. As MM does not include for liquid assets creation it cannot reflect banks value. They construct model including liquidity premium and conclude that liquidity creation activities require high capital. Authors conclude that banks produce liquidity by making capital choices; therefore they will prefer debt to equity even in the absence of taxes and other above mentioned frictions. Lower leverage becomes optimal only when market premium on liquidity increases.

Previously studied papers focused mostly on the effect of market frictions and increasing capitalization on private benefits of banks. But wellbeing of individual banks is not the goal of financial regulations. By introducing new requirements financial authorities analyze its benefits for the whole economy. Admati et al. (2013) and Vickers (2012) point out that social cost is the only factor that matters in the discussion of new regulations implementation. For example, while

bailout reduces private cost associated with debt as borrowers do not bear losses in case of banks insolvency it affects social costs Vickers (2012).

Admati et al. (2013) state that high leverage is not necessary conditional of banking operations and deleveraging may be costly for individual banks or their managers, but beneficial to the whole economy. They distinguish eight widely used reasons why banks would remain leveraged and prove them all to be wrong from the point of view of benefits for the economy. They confirm that banks do not have individual optimal leverage ratio higher than socially optimal. It means that once the leverage is in place and banks creditors does not have concerns about its level it would continue to increase beyond optimal bounds.

Tax benefits are a significant incentive to hold more debt. But taxes do not disappear from banks revenues in vain, they remains in the economy and are transferred to create additional social benefits. Similarly to taxes bailout guarantees that provoke banks to excessive risk taking and provide marginal benefits have not the same influence to the economy, as require investing large funds to save banks and withdraw them from other socially beneficial activities.

The higher debt may discipline managers, but they are less capable to maintain the same quality of monitoring while the debt increases. Depositors also not have enough incentives to perform monitoring as they are protected by government. Meanwhile high leverage may increase monitoring costs on the national and supranational level as more attentive government monitoring is required for highly leverage firms.

Reliance on hybrid instrument, proposed by Calomiris & Herring (2011) cannot be optimal in Admanti et al. (2013) opinion as it uses ex post trigger so recapitalization will occur after the negative event strikes.

Admati et al. (2013) provide only theoretical analysis, so their results might be interesting to prove using econometrical models to get more accurate proof and quantitative estimations.

Chapter 3. Empirical study methodology

The purpose of this paper is to measure to what extent MM theorem hold for banks and if there are differences between countries in terms of leverage influence on cost of capital. To verify Modigliani-Miller theorem applicability we start from calculating beta measure of systematic risk and study relationship between banks capital structure and beta.

CAPM and systematic risk measure[6]

Traditional CAPM model (Sharpe, 1964; Lintner, 1965) is one of the most widely used model of capital assets pricing. According to this model investors receive compensation for risk and time value of money and cost of capital can be calculated as:

$$E(R_i) = R_f + \beta_i(E(R_m) - R_f),$$

Where $E(R_i)$ – return on asset, R_f – risk free rate of return, representing time value of money, R_m – market return, β_i – asset's beta, measure of systematic risk.

Statistically beta measure can be defined as:

$$\beta_i = \frac{\sigma_{im}}{\sigma_m^2},$$

Where σ_{im} is the covariance between stock return and market return and σ_m^2 is the variance of market return.

The CAPM model does not take into account unsystematic risk as it is assumed efficient market and all specific risks can be diversified. It also assumes normal distribution of returns and possibility of riskless borrowings.

CAPM model assumptions are strict, but CAPM provides reliable estimations and widely used by practitioners (Estrada, 2007; Graham and Harvey, 2001, Bruner et al., 1998), especially in developed markets. It is also used by Federal Reserve System to assess banks level of risk (King, 2009).

The beta of a portfolio represents weighted average of individual assets betas. Taking into account this notion and Modigliani-Miller proposition I for company we decompose firm assets beta the following way:

$$\frac{D}{D+E}\beta_D + \frac{E}{D+E}\beta_E = \beta_U,$$

Where β_D – beta of debt, β_E – beta of equity, β_U – assets beta of the unlevered firm.

We consider banks being able to borrowings to be riskless, so $\beta_D = 0$. Assuming that $\beta_U = \beta_{TS}$ we can get the new equation:

$$\beta_U = \frac{E}{D+E}\beta_E \text{ or}$$

[6] This section is based on Brealey, R.A., Myers, S.C. & Allen, F. (2010) Principles of corporate finance. The McGraw-Hill/Irwin series in finance, insurance, and real estate. 10th Edition.

$$\beta_E = \frac{D+E}{E}\beta_U.$$

$\frac{D+E}{E}$ is leverage of the company, so beta expected to increase with the leverage. By this equation we establish the link between CAPM model and Modigliany-Miller theorem and supports linear relationship between beta and leverage.

The model

In this research we use extended, compared to previous similar studies, sample of banks from Eurozone, UK and US. We try to cross-country difference in reaction of banks risk to changes in leverage.

First step is to obtain beta, according to CAPM model. We build simple linear regression model and regress daily stock returns of each of selected banks on the daily returns of corresponding market index over a period of six months using OLS method. This estimation is also known as Scholes-Williams equity beta.

$$R_i = \alpha_i + \beta_i R_m$$

Six months period is chosen as banks mostly report data on capital semi-annually and this frequency enables us to analyze betas over similar periods for all banks.

As was stated in the previous section beta also depends on company's leverage. Therefore to reveal relationship between beta and leverage we construct panel data regression where beta is the dependent variable:

$$\beta_{it} = X'_{it}b + z'_t c + u_{it}$$

$$u_{it} = \alpha_i + \varepsilon_{it},$$

Where α_i is a bank specific effect, X'_{it} is a vector of regressors, z'_t - vector of dummy variables.

We include time dummies in the form of year dummy to capture common influence on all banks betas over time, for example financial crisis. We use 2014 as a reference year for time dummies.We also add Basel II and Basel III dummy, equals 1 for observations after 2008 and for observations in 2014 correspondingly. We expect these variables to capture the effect of changed capital definitions and increased requirements.

We would analyze panel data using three methods: OLS estimation, fixed effects (FE) model and random effects (RE) model which enable us to take into account unobserved effects or unobserved heterogeneity. In fixed effects model parameter α_i is treated as random variable as

a specific to the bank parameter. Estimated value of α_i is constant and different for each bank in the sample. Fixed effect α_i can be correlated with X_{it}. Random effects model suppose that α_i is a random variable. It accounts for time- and company-specific characteristics of the bank. RE model is consistent when $cov(X_{it}, \alpha_i) = 0$. If consistency condition for RE model is met the RE model should be preferred as it avoid loss of degrees of freedom and therefore is more efficient than FE estimation.

Next we move to quantifying the impact of leverage on funding cost of the bank. We determine the cost of bank's funds as weighted-average cost of capital:

$$WACC = R_E \frac{E}{V} + R_D \frac{D}{V},$$

Where company's value V=E+D (E – value of equity, D – value of debt). R_E – estimated return on equity.

As we already mentioned, we consider debt risk to be zero due to character of banks debt and existence of implied guarantees, thus interest rate of debt (R_D) equals risk-free rate (R_f).

R_E is estimated from CAPM model and obtained results for panel data regression. We can express R_E the following way:

$$R_{Eit} = R_f + (\hat{\alpha} + \hat{b} Leverage_{it})\ (E(R_m) - R_f),$$

Where $\hat{b}$ is the coefficient before leverage estimated in panel regression, $(E(R_m) - R_f)$ – market risk premium.

Market risk premium is not just a simple excessive return of market index but a reflection of market participants' estimation of risk and price of risk they want to receive. We will use consensus estimate for equity premium made by Ivo Welch[7] (2008). This estimate reflects opinion of 400 US and foreign to US finance professors on 1-year and 30-year risk premium. The recommended range for market risk premium is from 4% to 6%. Updated research states that financial professionals lowered their estimations by 0.6%-0.7% from 2001. Considering this information we would use market risk premium of 5 %, which is similar to the value used by Miles et al. (2012). As the level of risk free rate has no critical influence on results we decide to follow Miles et al. (2012) and choose risk free rate equal to 5%.

[7] Update of the original Welch, I. (2001), The equity premium consensus forecasts revisited, Cowles Foundation, Discussion Paper No. 1325

The cost of capital can be adjusted for taxes by multiplying second component by $(1 - \tau)$. We use information on marginal tax for corresponding region provided by KPMG[8]: 21% for UK, 40% for US and 30.3% for sample EU countries.

Data

In our empirical study we use data on 21 largest listed banks from Eurozone, UK and USA[9]. Our definition of banks size is based on banks' book asset value and the list is formed using SNL Financial rank "Largest 100 banks in the world[10]" and historical total assets values reported by banks. Using semi-annually financial reports available at Capital IQ database and daily stock prices and index values data from Bloomberg we from an unbalanced panel dataset over the period from 2006:1H to 2014:2H.

The use of limited number of companies is justified by the structure of banking industry where several largest banks control major part of banking industry assets in the region. Table 2 presents share of sample banks' assets compared to total industry assets and size of the sample compared to the size of the industry. For each region banks selected for the purpose of this research represent more than 40% of total banking industry assets while the sample includes less than 1% of companies in the industry. Such selection method may make RE effect approach for panel regression more suitable.

Table 2. Concentration of banking assets in the sample banks (2014)

Region	Share of sample banks assets in total banks assets	Share of sample in total number of banks
Eurozone	41.5%	0.2%
UK	72.1%	1.1%
US	43.7%	0.1%

The dependent variable in our regression analysis is banks equity beta. The inputs to the initial beta regression are daily stock returns calculated from daily stock prices and daily returns of corresponding regional market index. In our analyzed we have chosen following indices: FTSE 100 for UK, S&P 500 for US and STOXX Europe 600 for Euro area.

The primary explanatory variable is leverage. We use regulatory leverage measure calculated as Total assets/Tier 1 capital which is not affected by the method of risk-weighted

[8] KPMG. Corporate tax rates table. [Online] Accessed 20th May 2015. Available from: http://www.kpmg.com/global/en/services/tax/tax-tools-and-resources/pages/corporate-tax-rates-table.aspx
[9] Full list of sample banks is found in Appendix 2.
[10] SNL Financial rank "Largest 100 banks in the world" (December 23, 2013) . [Online] Available from: https://www.snl.com/InteractiveX/Article.aspx?cdid=A-26316576-11566 [Acceded 10th May 2015]

assets calculation. We also examine the possible use of Tier 1 capital ratio i.e. Tier 1 capital/Risk-weighted assets. However we have several concerns regarding this measure. Tier 1 ratio is not completely comparable over time as definition of both Tier 1 ratio and RWA changed significantly over time. It has also shown upward trend during studied period that may cause misleading coefficient values. Finally, there is no theoretically proved connection between cost of equity and Tier 1 ratio, so leverage seems to be more appropriate for this type of study.

We add bank specific independent variable to capture specific risks: liquidity proxy and profitability proxy. Loan-to-deposit ratio is used as a proxy of liquidity to represents the maturity transformation activities of the bank. Loan-to-deposit ratio generally has no upper limit. If the ratio is equals or above 100% loans are funded by borrowing and banks have shortage of cash in case of contingency.

Profitability is expected to have an influence on overall risk of the bank. Miles et al. (2012) suggest using ROA as a profitability measure, but in their result for a subset of largest UK banks this variable is insignificant. Furthermore, using DuPont decomposition of ROE we can get $ROA = ROE * \frac{Equity}{Total\ Assets}$, so we can expect ROA to be correlated with capital ratio and leverage. However we include ROA in the list of bank specific variable for further study.

The lagged values of leverage, ROA and liquidity are used in the model to address potential endogeneity. In table 4 presented the correlation matrix for leverage and independent variables. There is no excessive correlation between regressors used in our analysis. Contrary to expectations, correlation between ROA and leverage does not exceed acceptable level and even if it is the highest compared to others we can use it for the purpose of analysis.

Table 3. Correlation matrix

	Tier 1 ratio	**ROA**	**LTD**	**Leverage**
Tier 1 ratio	1			
ROA	-0.1122	1		
LTD	-0.2877	-0.1435	1	
Leverage	-0.2312	-0.3192	0.0012	1

Chapter 4. Estimation results

Mean and median betas of banks in our sample are generally higher than 1, meaning that banks stock prices are more volatile than corresponding market index.

Table 4. Mean and median beta values for studied regions and the whole sample for the period 2006-2014

	Mean	Median
US	1.457	1.324
UK	1.405	1.289
Eurozone	1.563	1.522
Total	1.487	1.414

Evolution of beta through time also shows similarities between countries. There is a sharp increase of beta during the financial crisis of 2007-2008, most evident in UK and US, followed by a fast return to pre-crisis level in 2010. Another significant increase corresponds to Cypriot financial crisis which had more effect on Eurozone and UK banks. Beta values also show upward trend over 9 years studied with average beta in 1H2006 of 1.10 and in 2H2014 already reached 1.28. This trend is more evident in Euro area with average beta increased by 44% over 9 year period.

Figure 3.Comparison of median sample betas between regions (2006-2014)

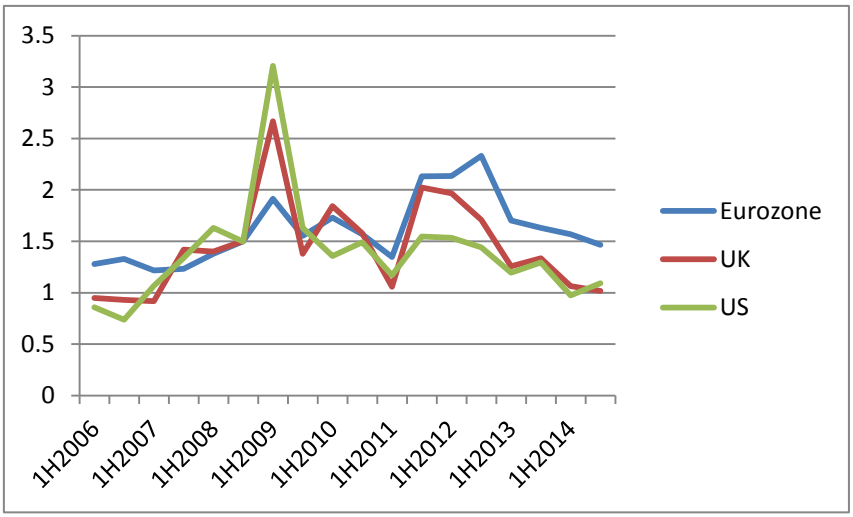


Table 5 and appendix 4 present descriptive statistics for the whole sample of 21 banks and for each of three regional subsamples. The leverage measure shows higher variation compared to Tier 1 capital ratio, which can partially be explained by higher variation of Total assets compared to Risk-weighted assets variation. It may also be more capable to capture changes in beta values over time. We can also notice an outstandingly high maximum value of loans-to-deposits ratio which corresponds to Euro area subsample.

Table 5. Descriptive statistics for the whole sample

	Mean	Minimum	Maximum	Std Dev	Lower Quartile	Median	Upper Quartile	Coefficient of variation
Beta	1.487	0.459	3.520	0.485	1.160	1.414	1.764	0.326
Tier 1 ratio	0.106	0.041	0.173	0.023	0.086	0.109	0.123	0.214
Leverage	25.795	10.540	74.570	12.258	16.685	22.380	30.949	0.475
ROA	0.002	-0.018	0.011	0.003	0.001	0.002	0.004	1.627
LTD	1.043	0.439	5.923	0.414	0.785	1.003	1.188	0.397

Bank specific variables are close among regional subsamples, but there are several outstanding values. The Euro area leverage indicator is two times higher than median leverage in US and slightly higher than UK mean leverage. This is in line with higher beta values typical for Euro zone. UK banks profitability is 1.5 times higher than profitability in the peer regions. These geographic location specific characteristics can have significant impact on beta reaction to leverage.

We conduct Fisher type unit root test for panel data on beta, Tier 1 capital ratio and leverage to verify that panel is stationary. Fisher type unit root test is based on Dickey-Fuller unit root test. The null hypothesis is that all panels contain unit roots. For both beta and leverage the null hypothesis that all the panels contain unit roots can be rejected at 5% significance level. Therefore we suppose that beta and leverage are trend stationary and will use leverage as an explanatory variable in the regression. For Tier 1 capital ratio the null hypothesis cannot be rejected at 10% significance level, which means that it is not trend stationary.

We estimate two models: basic regression model, which involves only leverage and time dummies as explanatory variables, and extended model involving additional bank specific variables. We conduct Hausman test to choose between FE and RE models. The null hypothesis of the test is that both FE and RE are consistent. In case when the null hypothesis is not rejected we should chose RE model as it provides more efficient estimations. For our total sample the null hypothesis of Hausman test is not rejected so we conclude that RE fits data the best. This result contradicts with Miles et al. (2012) where authors conclude FE to be the most suitable estimation method.

Results of regression analysis on the total sample (Table 6) are not completely consistent with previous studies (Miles et al., 2012, Bandt et al.). The coefficient estimate on leverage is

positive and significant for OLS and RE estimations. However this coefficient is it is insignificant for FE estimation which contradicts with existing literature. Miles et al. (2012) finds RE and OLS leverage coefficient of 0.025, while in our analysis it is more than 2 times smaller. We also find significant impact of lagged value of ROA and loans-to-deposits ratio on beta. Addition of these bank specific characteristics produces marginal increase in R-squared, but significantly decrease leverage coefficient estimations. We suppose that these differences of our results from evidences presented in existing literature are caused by significant time-varying banks specific characteristics.

Table 6. Results for OLS, FE and RE estimation of basic and extended model for the whole sample

	Basic model			**Extended model**		
	OLS	**FE**	**RE**	**OLS**	**FE**	**RE**
Leverage	.0103539	.0028292	.0082816	.0053481	.0016728	0.0049453
	(5.68)	(0.58)	(2.74)	(2.84)	(0.36)	(1.79)
Const	.791305	1.031061	.8722454	1.076225	.984335	0.9867516
	7.33	(6.21)	(6.76)	(7.55)	(4.76)	(6.00)
ROA				-47.4143	-42.90171	-44.10746
				(-6.69)	(-5.51)	(-5.96)
LTD				.0933865	.2701716	0.1855195
				(1.50)	(2.75)	(2.33)
R^2 overall	0.3642	0.3324	0.3621	0.4527	0.4273	0.4484
R^2 between					0.3938	0.5008
R^2 within					0.4388	0.4363
F-test/Wald test	21.26	20.40	192.55	24.96	22.18	261.43
Prob>F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

We suppose that estimation of separate regressions for each region should give better resulted and a second step we perform similar regression analysis for each geographic subsample separately. The results we get (Appendix 5) show significant differences from previously estimated regression and are more consistent with existing literature.

For all subsamples Hausman test results show that RE model is more suitable. We obtain leverage coefficients of 0.011721 for Euro area, .031383 for UK and 0.0660654 for US. Miles et al. (2012) FE estimation of the same coefficient for UK

In our estimations leverage coefficient for the sample of UK banks is 0.026, while according Miles et al. (2012) is equals 0.031. The loans-to-deposits ratio is significant only in the panel for Euro area. Mean LTD for the sample of European banks exceeds 1, which implies that they are systematically borrowing to expand lending activities. Therefore we might suggest that banks systematic risk reacts only to extremely high levels of LTD and constant shortage of cash.

Contrary to Miles et al. (2012) results ROA appears to be significant in all subsample regressions. However introduction of additional independent variable does not result in significant increase of explanatory power of regressions.

All specifications include year effect that are significant especially in periods of financial instability and reflect overall changes in risk perception by investors.

We rerun our models to check for Basel II and Basel III implementation impact of beta. In all cases coefficients before both regulatory changes variables are insignificant, which does not mean that they did not affected betas. As their effect on beta is translated through leverage ratio the implementation of new regulatory framework itself does not change market participants models of firm risk assessment.

Chapter 5. Measurement of leverage influence on total cost of capital

To assess the impact of leverage on cost of equity we will use result from simple RE panel model estimation and average leverage level for each subsample during 2014.

Table 7. Cost of equity estimation

	Euro area	UK	US
Average leverage	25.7902	20.9697	12.5233
$\hat{\alpha}$	0.9378	0.4288	0
$\hat{b}$	0.0117	0.0314	0.0660
Cost of equity (no taxes)	11.198%	10.436%	9.133%
WACC (no taxes)	5.24%	5.26%	5.33%
Cost of equity (with taxes)	9.360%	9.685%	8.165%
WACC (with taxes)	3.72%	4.22%	3.41%

Now we suppose the case of doubling capital, therefore leverage will be halved. The results are presented in table 8. The cost of equity with taxes is calculated using Hamada equation: $R_i = R_f + \beta_i(1-\tau)(R_m - R_f)\frac{D_i}{E_i}$.

Table 8. Changes in cost of equity and WACC if capital doubles.

	Euro area	UK	US
Average leverage	12.8951	10.4849	6.2617
Cost of equity (no taxes)	10.443%	8.790%	7.066%
Δ Cost of equty (no taxes)	0.755 pp	-1.646 pp	-2.067 pp
WACC (no taxes)	5.42%	5.36%	5.42%
Δ WACC (no taxes)	0.18 pp	0.10 pp	0.09 pp
WACC (no taxes, no MM)	5.48%	5.52%	5.66%
Δ WACC (no taxes, no MM)	0.24 pp	0.26 pp	0.33 pp
MM offset (no taxes)	25%	61%	73%
Cost of equity (with taxes)	8.700%	9.012%	7.706%
WACC (with taxes)	3.97%	4.43%	3.75%
Δ WACC (with taxes)	0.25 pp	0.21 pp	0.34 pp
WACC (with taxes, no MM)	3.94%	4.50%	3.82%
Δ WACC (with taxes, no MM)	0.22 pp	0.28 pp	41 pp
MM offset (with taxes)	-13%	25%	24%

We can see that increase in leverage lead to increase in total cost of capital. Taking into account this results we cannot say that MM theorem hold perfectly for banks. However, if MM does not hold at all, cost of equity would be unaffected by changes in leverage and we would see higher increase in WACC. MM offset is calculated estimated change in WACC by comparing change in WACC if cost of equity remains constant with increasing leverage. It measures to what extent MM theorem holds for each region. Conforming to our expectations MM offset decreases with addition of taxes; however it remains positive in US and UK. Negative MM offset for Euro area suggests that there are extra frictions that affect banks cost of capital.

Conclusion

Global economy endured severe losses during financial crisis. The necessity to reduce the probability of occurrence of such events in the future is obvious and demand to increase banks capitalization is one of possible means to address the problem. However there is still no agreement in the estimation private and social of costs associated with such requirement.

MM theorem states that change in capital structure will not affects funding costs thus will have close to zero effect on banks activities. Nevertheless the theorem does not hold in pure form in reality due to existing market frictions. We conduct a panel regression analysis to confirm that MM theorem holds for banks in Euro area, UK and US over the period 2006-2014. We test the impact of leverage, liquidity and profitability of the bank on its risk. Afterwards we quantify an impact of changes in leverage on cost of capital through changing cost of equity and compare our result with hypothetical situation when cost of equity is not affected by changes in leverage. Evidences prove existence of significant differences in beta reaction to leverage changes among countries, thus the estimations should be conducted separately for individual countries or common currency areas.

Our results conforms to MM proposition II and existing literature on the topic and beta increases when the leverage increases. The influence of liquidity and profitability on risk is less obvious, but we can suppose that increase in profitability has significant negative influence on risk, while liquidity determined as loans-to-deposits ratio is significant only if it reflects excessive lending activities of the bank. We also confirm that total funding costs would likely increase after new capital regulations adoption. The level of increase in WACC varies among countries from 0.09pp to 18pp for 50pp decrease in leverage. However it is smaller than expected under assumption of complete irrelevance of MM theorem. We conclude that there is a MM effect greater than 60% in UK and US, but only of 25% in Euro area. The MM diminishes significantly if taxes are included in the model, but as they are not the losses for the economy, so the more in-depth analysis of costs and benefits is required to make conclusions about model with taxes.

While deleveraging may not solve all banking system problems it is capable to reduce risk of individual bank as well as risk of default for the economy. As a further development of studies in this area we would like to suggest cross-country analysis of leverage influence on beta and analysis of larger set of banks specific and country specific variables to explain the origins of difference in banks risk reaction to leverage.

Appendix 1. List of global systemically important banks[11]

Bank name	Additional loss absorbency	Country
Agricultural Bank of China	1.0%	China
Bank of China	1.0%	
Industrial and Commercial Bank of China Limited	1.0%	
BNP Paribas	2.0%	France
Groupe BPCE	1.0%	
Group Crédit Agricole	1.0%	
Société Générale	1.0%	
Deutsche Bank	2.0%	Germany
Unicredit Group	1.0%	Italy
Mitsubishi UFJ FG	1.5%	Japan
Mizuho FG	1.0%	
Sumitomo Mitsui FG	1.0%	
ING Bank	1.0%	Netherlands
BBVA	1.0%	Spain
Santander	1.0%	
Nordea	1.0%	Sweden
Credit Suisse	1.5%	Switzerland
UBS	1.0%	
HSBC	2.5%	UK
Barclays	2.0%	
Royal Bank of Scotland	1.5%	
Standard Chartered	1.0%	
JP Morgan Chase	2.5%	USA
Citigroup	2.0%	
Bank of America	1.5%	
Goldman Sachs	1.5%	
Morgan Stanley	1.5%	
Bank of New York Mellon	1.0%	
State Street	1.0%	
Wells Fargo	1.0%	

[11] Source: http://www.financialstabilityboard.org/wp-content/uploads/r_141106b.pdf

Appendix 2. Sample of banks studied

Bank	Total assets, EUR million, 2014	Country
BNP Paribas	2 077 759	France
Natixis	590 424	France
Group Crédit Agricole	1 589 076	France
Société Générale	1 308 170	France
Deutsche Bank	1 708 703	Germany
Commerzbank AG	557 609	Germany
Unicredit Group	844 217.4	Italy
ING Bank	992 856	Netherlands
BBVA	631 942	Spain
Intesa Sanpaolo S.p.A.	646 427	Spain
Santander	1 266 296	Spain
KBC Group	245 174	Belgium
Erste Group	196 287	Austria
HSBC	2 400 095	UK
Barclays	1 889 661.8	UK
Lloyds Banking Group	854 896	UK
Royal Bank of Scotland	1 462 241.6	UK
Standard Chartered	661 416.5	UK
JP Morgan Chase	2 344 503.8	USA
Citigroup	1 678 821.2	USA
Bank of America	1 917 546.2	USA
US Bancorp	366 764.3	USA
Wells Fargo	1 583 339.1	USA

Appendix 3. Beta estimation results

Period	BNP Paribas	Natixis	Crédit Agricole	Société Générale	Deutsche Bank	Commerz bank AG	Unicredit Group	ING Bank	BBVA	Intesa Sanpaolo	Santander	HSBC	Barclays	Lloyds	The Royal Bank of	Standard Chartered	Bank of America	Citigroup	JPMorgan	US bancorp	Wells fargo	*Mean*	*Median*
2H2014	1.28	1.30	1.36	1.32	1.19	1.53	1.43	1.25	0.97	1.00	1.05	0.72	1.15	0.95	0.87	1.25	0.86	0.92	1.25	0.61	0.76	*1.28*	*1.24*
1H2014	1.55	1.15	1.61	1.33	1.55	1.37	0.94	1.39	1.25	0.84	1.30	0.86	1.22	0.87	0.93	1.42	0.74	0.93	1.28	0.46	0.65	*1.36*	*1.33*
2H2013	1.27	1.06	1.22	1.22	1.30	1.21	1.00	1.01	1.30	0.92	1.26	0.56	1.38	0.81	0.92	1.23	0.98	1.22	1.24	0.70	1.07	*1.45*	*1.42*
1H2013	1.35	1.78	1.23	1.41	1.13	1.38	1.46	0.88	0.65	0.71	0.62	0.84	1.52	1.13	1.50	1.42	1.14	1.42	1.41	1.20	1.34	*1.37*	*1.34*
2H2012	1.39	1.49	1.56	1.38	1.23	1.83	0.97	1.46	0.71	0.89	0.67	0.97	1.61	1.39	1.77	1.40	1.61	2.13	1.63	1.14	1.78	*1.93*	*1.87*
1H2012	1.18	1.50	1.52	1.28	1.75	1.58	1.55	2.11	0.94	1.35	0.99	0.93	1.50	1.24	1.53	1.63	1.91	1.92	1.50	1.12	1.42	*1.90*	*2.09*
2H2011	2.21	1.71	1.91	1.79	2.24	2.06	2.01	2.86	1.38	1.62	1.47	1.89	3.14	3.19	2.67	1.87	3.52	3.22	2.57	2.29	3.20	*1.86*	*2.02*
1H2011	1.45	1.65	1.55	1.42	1.68	1.87	1.59	2.34	1.02	1.37	1.09	1.36	1.72	1.18	1.82	1.38	1.63	1.56	1.63	1.44	1.65	*1.23*	*1.17*
2H2010	1.68	1.79	1.61	1.79	1.47	1.05	1.95	2.34	1.67	1.85	1.73	0.93	2.18	1.91	1.84	1.46	1.52	1.47	1.30	1.09	1.36	*1.54*	*1.57*
1H2010	1.77	1.57	1.94	2.05	1.29	0.96	1.55	1.92	1.36	1.64	1.43	1.01	1.73	1.58	1.58	1.25	1.73	1.43	1.41	1.49	1.68	*1.62*	*1.67*
2H2009	1.35	1.16	1.35	1.47	1.21	1.26	1.40	1.60	1.17	1.64	1.12	0.93	1.16	1.06	1.11	1.00	1.23	1.13	1.17	1.10	1.22	*1.54*	*1.56*
1H2009	2.20	1.97	2.20	2.63	1.98	2.17	1.94	2.35	1.25	2.13	0.99	1.15	2.33	2.02	2.05	1.27	2.04	2.08	1.55	1.31	1.46	*2.33*	*2.21*
2H2008	2.10	2.13	2.25	2.47	1.85	2.09	2.54	2.45	1.32	2.25	1.14	1.15	2.19	2.02	1.97	1.36	2.35	2.23	1.53	1.15	1.42	*1.45*	*1.50*
1H2008	2.27	2.41	2.79	2.63	2.33	2.15	2.43	2.10	1.85	2.48	1.56	1.29	2.24	1.71	1.85	1.26	1.75	1.87	1.44	0.98	1.19	*1.38*	*1.40*
2H2007	1.85	1.06	1.89	2.04	1.63	0.60	1.72	1.70	1.08	1.76	1.10	1.26	1.67	1.15	1.34	1.19	1.37	1.60	1.20	0.68	0.96	*1.21*	*1.34*
1H2007	1.57	1.42	1.63	1.99	1.30	1.85	1.73	1.78	1.17	1.81	1.13	1.18	1.20	1.34	1.59	1.46	1.41	1.50	1.30	0.92	1.16	*1.09*	*1.21*
2H2006	1.51	1.45	1.57	1.82	1.37	1.86	2.06	1.68	1.53	1.83	1.19	0.91	1.21	1.06	1.33	1.04	0.97	1.24	1.11	0.91	0.95	*1.12*	*1.22*
1H2006	1.36	1.52	1.47	1.62	1.31	1.43	1.89	1.55	1.10	1.84	1.15	1.02	1.29	0.99	1.17	0.71	1.09	1.24	1.17	1.00	0.97	*1.10*	*1.15*
Mean	*1.63*	*1.56*	*1.70*	*1.76*	*1.55*	*1.57*	*1.67*	*1.82*	*1.21*	*1.55*	*1.17*	*1.05*	*1.69*	*1.42*	*1.55*	*1.31*	*1.55*	*1.62*	*1.43*	*1.09*	*1.35*		
Median	*1.53*	*1.51*	*1.59*	*1.71*	*1.42*	*1.56*	*1.66*	*1.74*	*1.21*	*1.64*	*1.14*	*0.99*	*1.56*	*1.21*	*1.56*	*1.32*	*1.46*	*1.49*	*1.36*	*1.10*	*1.28*		

Appendix 4. Descriptive statistics for regional subsamples

Table 5-1. Descriptive statistics for US banks

	Mean	Minimum	Maximum	Std Dev	Lower Quartile	Median	Upper Quartile	Coefficient of variation
Beta	1.405	0.459	3.520	0.537	1.101	1.304	1.598	0.382
Tier 1 ratio	0.107	0.041	0.145	0.021	0.088	0.111	0.122	0.198
Leverage	14.232	10.540	24.516	2.746	12.232	13.889	15.166	0.193
ROA	0.004	-0.010	0.011	0.004	0.003	0.004	0.007	0.845
LTD	0.848	0.540	1.209	0.167	0.708	0.860	0.949	0.197

Table 5-2. Descriptive statistics for UK banks

	Mean	Minimum	Maximum	Std Dev	Lower Quartile	Median	Upper Quartile	Coefficient of variation
Beta	1.493	0.557	3.193	0.487	1.064	1.289	1.626	0.347
Tier 1 ratio	0.111	0.072	0.165	0.023	0.091	0.115	0.132	0.205
Leverage	25.018	15.054	55.114	8.089	21.850	19.356	22.697	0.323
ROA	0.0016	-0.0096	0.0067	0.0029	0.0005	0.0001	0.0019	1.791
LTD	0.959	0.693	1.500	0.200	0.916	0.785	0.913	0.209

Table 9. Descriptive statistics for Eurozone banks

	Mean	Minimum	Maximum	Std Dev	Lower Quartile	Median	Upper Quartile	Coefficient of variation
Beta	1.562	0.602	2.859	0.449	1.255	1.522	1.848	0.288
Tier 1 ratio	0.103	0.058	0.173	0.023	0.082	0.106	0.119	0.221
Leverage	31.798	14.710	74.570	12.650	21.850	27.940	40.340	0.398
ROA	0.001	-0.018	0.009	0.003	0.000	0.001	0.002	2.368
LTD	1.170	0.439	5.923	0.510	0.916	1.132	1.329	0.436

Appendix 5. Results for regressions on regional subsamples

Table 6-1. Regression results for Eurozone

	Basic model			Extended model		
	OLS	**FE**	**RE**	**OLS**	**FE**	**RE**
Leverage	.0106194	.0125584	.0117216	.0130237	.0116369	.013042
	(4.59)	(2.41)	(2.98)	(4.79)	(2.25)	(4.75)
Const	.915629	.9071895	.9378093	.6961477	.7748831	.6960843
	5.95	(4.22)	(4.98)	(3.16)	(3.04)	(3.16)
ROA				-30.64969	-19.12501	-30.14166
				(-3.21)	(-2.04)	(-3.16)
LTD				.2324872	.2063705	.2322704
				(2.94)	(2.23)	(2.93)
R^2 overall	0.4363	0.4334	0.4350	0.4725	0.4995	0.5061
R^2 between					0.4813	0.5088
R^2 within					0.5096	0.5041
F-test/Wald test	14.10	15.80	146.50	15.09	14.36	165.77
Prob>F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table 6-2. Regression results for UK

	Basic model			Extended model		
	OLS	**FE**	**RE**	**OLS**	**FE**	**RE**
Leverage	.032361	.0293488	.031383	.026848	.0275454	.0266976
	(6.52)	(2.94)	(4.57)	(4.95)	(2.67)	(3.35)
Const	.4082259	.4716329	.4288135	.5009388	.2964189	.3985193
	(2.86)	(2.05)	(2.41)	(2.42)	(0.77)	(1.33)
ROA				-33.22446	-32.09105	-32.14603
				(-2.20)	(-1.86)	(-1.96)
LTD				.0483682	.2539332	.1623909
				(0.31)	(0.92)	(0.73)
R^2 overall	0.5322	0.5310	0.5321	0.5584	0.5500	0.5558
R^2 between					0.7424	0.7638
R^2 within					0.4929	0.4923
F-test/Wald test	11.63	8.43	88.76	10.35	7.51	92.47
Prob>F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Table 6-3. Regression results for US

	Basic model			Extended model		
	OLS	**FE**	**RE**	**OLS**	**FE**	**RE**
Leverage	.0755672	.0478889	.0660654	.0203527	.0010359	.0203527
	(5.68)	(1.65)	(3.00)	(0.86)	(0.04)	(0.86)
Const	-.4322357	.0227642	-.2760363	.7454311	-.1488607	.7454311
	(-1.30)	(0.05)	(-0.70)	(1.15)	(-0.20)	(1.15)
ROA				-70.00285	-71.20025	-70.00285
				(-4.63)	(-4.00)	(-4.63)
LTD				.2824167	1.585878	.2824167
				(0.92)	(2.14)	(0.92)
R^2 overall	0.6009	0.5890	0.5996	0.6941	0.5604	0.4484
R^2 between					0.0935	0.5008
R^2 within					0.6803	0.4363
F-test/Wald test	12.55	11.53	110.16	15.06	13.35	261.43
Prob>F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

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